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Snow Damage in Arizona Ponderosa Pine Stands

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Snow damage in three cutover ponderosa pine stands was evaluated following a year of record snowfall in north-central Arizona. Susceptibility to bending decreased as d.b.h. increased. Dense sapling stands suffered significantly more damage than thinned areas. Thinning early in the sapling stage is recommended to reduce the snow damage potential.

Keywords: *Pinus ponderosa*, snow damage.

Dense conifer stands in sapling and pole sizes are frequently damaged by heavy snow (Fenton 1959, Kangur 1973, Powers and Oliver 1970, Watt 1951). However, little information is available to characterize snow damage in ponderosa pine (*Pinus ponderosa* Laws.) stands in Arizona. Pearson (1950) reported pole-sized trees may be seriously damaged by snow, and Schubert (1971) found 12 percent of the trees in the Taylor Woods thinning study, mostly saplings, were bent or broken after a spring of wet snow.

In the study reported here, snow damage in three cutover ponderosa pine stands was evaluated following a year of record snowfall in north-central Arizona. Snow damage and subsequent recovery are related to tree size and stand density.

Methods

The three study areas were located: (1) 8 miles south of Flagstaff, on the Coconino National Forest; (2) 6 miles east of McNary, on the Fort Apache Indian Reservation; and (3) 7 miles south of Alpine, on the Apache-Sitgreaves National Forest. Uneven-aged stands of cutover ponderosa pine, with different age classes occurring as even-aged groups, characterize the areas. Some areas had been thinned at least 10 years previously. Site index values range from 50 to 75 feet at 100 years (Minor 1964). Elevations extend from 7,400 to 8,000 feet, and soils on all areas are developed from basalt and volcanic cinders.

One-fifth-acre plots were permanently established on the study areas, 30 each at Flagstaff and McNary, and 40 plots at Alpine. Trees on each plot were tallied by diameter at breast height (d.b.h.) as part of other investigations. After the record snowfall in 1972-73 (Barnes et al. 1974), these tallies provided the base from which snow damage was evaluated. Following this season of record snowfall, trees were classified as bent, broken, or not damaged. Damaged trees were reexamined annually for 3 years to determine recovery.

Results and Discussion

No differences were found in the size of trees or density of stands damaged by snow among the three study areas. Therefore, the data were grouped for further analysis.

While a few broken tops were observed, most of the damage resulting from the 1972-73 snowfall involved bent stems. Bending varied from slight deviations in straightness to situations where bowed stems almost touched the ground (fig. 1). Subsequent recovery of bent stems has been slow; over 95 percent of the trees initially damaged are still bent to some degree 3 years later. No mortality attributable to snow damage was recorded.

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Figure 1.—Snow damage on the White Mountain sample plots consisted mainly of bending. Bending varied from a slight lean to situations where the crowns touched the ground.

Susceptibility to bending by snow decreased as d.b.h. increased. Most of the bending was confined to saplings (2-inch d.b.h.), with no damage in trees over 6 inches d.b.h.:

D.b.h. (Inches)	Total trees	Bent stems
	(No./acre)	
2	158.8	30.6
4	120.7	4.58
6	90.6	0.37
8	58.7	0

Although we found no relationship between snow bending and total stand basal area, dense sapling stands suffered significantly more damage than thinned areas. The dense, meshlike canopy structure of these stands intercepted and accumulated heavier snow loads than isolated tree crowns. Also, when these sapling stands occur as an understory, the snow loads released from the overstory crowns can increase the bending damage (fig. 2).

We found no relationship between the little stem breakage that was observed and tree size or stand density; similarly, there was no correlation between height to break and total height.

The potential damage arising from excessive snow loads might be reduced in Arizona ponderosa pine by thinning early in the sapling stage. Apparently, trees grown in open stands in seedling and sapling stages are better able to resist snow damage (Kangur 1973).

Figure 2.—Dense stands had more snow damage than thinned stands, and the smaller trees were hardest hit.

Literature Cited

Barnes, James C., Clinton J. Bowley, and David A. Simmes.
1974. The application of ERTS imagery to mapping snow cover in western United States. ERTS Type III Final Report, NASA-LR-137223, Natl. Tech. Inf. Serv. E74-10400, 80 p.

Fenton, R. H.
1959. Heavy snowfalls damage Virginia pine. U.S. Dep. Agric., For. Serv., Northeast For. Exp. Stn., Res. Note 92, 4 p. Upper Darby, Pa.

Kangur, Rodolf.
1973. Snow damage to young western hemlock and Douglas-fir. Oreg. State Univ., For. Res. Lab., Res. Pap. 21, 11 p.

Minor, Charles O.
1964. Site-index curves for young-growth ponderosa pine in northern Arizona. USDA For. Serv. Res. Note RM-37, 8 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.

Pearson, G. A.
1950. Management of ponderosa pine in the Southwest. U.S. Dep. Agric., Agric. Monogr. 6, 218 p.

Powers, Robert F., and William W. Oliver.
1970. Snow breakage in a pole-sized ponderosa pine plantation . . . more damage at high stand-densities. USDA For. Serv. Res. Note PSW-218, 3 p. Pac. Southwest For. and Range Exp. Stn., Berkeley, Calif.

Schubert, Gilbert H.
1971. Growth response of even-aged ponderosa pine stands related to stand density level. J. For. 69:857-860.

Watt, R. F.
1951. Snow damage in a pole stand of western white pine. U.S. Dep. Agric., For. Serv., North. Rocky Mt. For. and Range Exp. Stn., Res. Note 2, 4 p. Missoula, Mont.

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